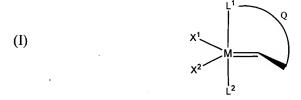
WE CLAIM:

- 1. A method for synthesizing a cyclic polymer via a ring insertion polymerization reaction, comprising combining, to provide a reaction mixture, a cyclic olefin monomer with a catalytically effective amount of a transition metal alkylidene complex containing a cyclic group of known size, whereby: the cyclic olefin monomer successively inserts into the cyclic group to increase the size thereof in a stepwise manner without detachment of any linear species from the complex; and following completion of polymerization on the transition metal alkylidene complex, the cyclic polymer is released from the complex by an intramolecular chain transfer reaction.
 - 2. The method of claim 1, wherein the reaction is carried out in the liquid phase.
 - 3. The method of claim 2, wherein a solvent is added to the reaction mixture.
- 4. The method of claim 2, wherein the cyclic olefin monomer serves as a solvent and no additional solvent is added to the reaction mixture.
- 5. The method of claim 2, further including precipitating the cyclic polymer by addition of a precipitating solvent to the reaction mixture.
- 6. The method of claim 5, further including isolating the precipitated polymer by filtration.
- 7. The method of claim 1, wherein the transition metal alkylidene complex has the structure of formula (I)



wherein:

M is a Group 8 transition metal;

L¹ and L² are neutral electron donor ligands;

 X^1 and X^2 are anionic ligands, and may be taken together to form a single bidentate ligand; and

Q is a linkage selected from optionally substituted and/or heteroatom-containing C_1 - C_{20} alkylene, C_2 - C_{20} alkenylene, C_2 - C_{20} alkynylene, C_5 - C_{24} arylene, C_6 - C_{24} alkarylene, and C_6 - C_{24} aralkylene linkages,

wherein L^1 and L^2 can be taken together with each other or with X^1 or X^2 to form a cyclic group, and further wherein any one of X^1 , X^2 , L^1 and L^2 , R^1 , and R^2 can be attached to a solid support.

- 8. The method of claim 7, wherein M is Ru or Os.
- 9. The method of claim 8, wherein M is Ru.
- 10. The method of claim 9, wherein:

L¹ is a carbene ligand;

L² is selected from phosphine, sulfonated phosphine, phosphine, phosphinite, phosphinite, arsine, stibine, ether, amine, amide, imine, sulfoxide, carboxyl, nitrosyl, pyridine, substituted pyridine, imidazole, substituted imidazole, pyrazine, and thioether; and

 X^1 and X^2 are independently selected from hydrogen, halide, C_1 - C_{20} alkyl, C_5 - C_{20} aryl, C_1 - C_{20} alkoxy, C_5 - C_{20} aryloxy, C_2 - C_{20} alkoxycarbonyl, C_6 - C_{20} aryloxycarbonyl, C_2 - C_{20} acyloxy, C_1 - C_{20} alkylsulfonato, C_5 - C_{20} arylsulfonato, C_1 - C_{20} alkylsulfanyl, C_5 - C_{20} arylsulfanyl, any of which, with the exception of hydrogen and halide, are optionally further substituted with one or more groups selected from halide, C_1 - C_6 alkyl, C_1 - C_6 alkoxy, and phenyl; and

Q is C_2 - C_{18} alkylene or C_2 - C_{18} alkenylene.

11. The method of claim 10, wherein:

L¹ is an N-heterocyclic carbene ligand;

 L^2 is a phosphine ligand of the formula $PR^1R^2R^3$, where R^1 , R^2 , and R^3 are each independently aryl or C_1 - C_{10} alkyl;

X¹ and X² are independently selected from halide, CF₃CO₂, CH₃CO₂, CFH₂CO₂, (CH₃)₃CO₃ (CF₃)₂(CH₃)CO, (CF₃)(CH₃).₂CO, PhO, MeO, EtO, tosylate, mesylate, and trifluoromethanesulfonate; and

Q is C_2 - C_{12} alkylene or C_2 - C_{13} alkenylene.

12. The method of claim 11, wherein the transition metal alkylidene complex has the structure of formula (IX)

(IX)
$$\mathbb{R}^{23} \xrightarrow{\mathbb{N}} \mathbb{N}$$

in which j is an integer in the range of 1 to 6 inclusive, X^1 and X^2 are halide, and R^{23} , R^{24} , and R^{25} are lower alkyl.

- 13. The method of claim 12, wherein j is 3, X^1 and X^2 are chloride, and R^{23} , R^{24} , and R^{25} are methyl.
 - 14. A transition metal alkylidene complex having the structure of formula (IX)

wherein:

j is an integer in the range of 1 to 6 inclusive;

M is a Group 8 transition metal;

 L^2 is a neutral electron donor ligand, and X^1 and X^2 are anionic ligands, wherein any two of L^2 , X^1 and X^2 can be taken together to form a single bidentate ligand; and

R²³, R²⁴, and R²⁵ are lower alkyl.

- 15. A cyclic hydrocarbon polymer substantially free of linear contaminants and having a number average molecular weight of at least about 150 kD.
- 16. The polymer of claim 15, having a number average molecular weight of at least about 500 kD.
- 17. The polymer of claim 16, having a number average molecular weight of at least about 1000 kD.
- 18. The polymer of claim 17, having a number average molecular weight of at least about 1200 kD.
 - 19. The polymer of claim 15, comprising a cyclic polyoctenamer.
 - 20. The polymer of claim 15, comprising cyclic polyethylene.
 - 21. The polymer of claim 15, comprising cyclic polybutadiene.
- 22. A polymer blend comprising the polymer of claim 15 and at least one second polymer.